The International Journal of Engineering and Science (IJES)
|| Volume || 13 || Issue || 10 || Pages || PP 90-95 || 2024 ||
ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

Flexural & Compressive Strength Behaviour of Low-weight Engineered Timber Slab(ETS) composed of crack filler, wood adhesive & Saw dust

Ezekiel. O. Ihemegbulem, N.S.M. Ogbonna
Civil Engineering Department @ Federal University of Technology, Owerri, Nigeria.

--***ABSTRACT***--

This study presents the Compressive & Flexural Strength performance of Low-weight Engineered Timber Slab(ETS) composed of wood adhesive, Saw dust, & crack filler. It provides empirical data on the flexural and compressive properties of engineered timber slab(ETS), which is an element of wood adhesive(WA), sawdust(SD), crack filler(CF). SD gave values of 562.3/m3, 0.67, 39.66%, 2.85, 1.2 and 2.98 for mean bulk density, mean specific gravity, mean water absorption, finess modulus, coefficient of curvature (Cc) and uniformity (Cu). Batching was done by volume by virtue of the low density of the component materials (SD & CF). The component materials were manually mixed. A total of twelve (12) cubes of size 150 x 150 x 150mm, were produced from mix ratios 0.5:0.5:2 & 0.5:0.75:2(WA : CF : SD) for compressive strength test. The above mix ratios were adopted based on the light-weight nature & high rate of water absorption of the component materials. A total of Twenty (20) slabs of size 300 x 300 x 100mm, 300 x 300 x 125mm, 300 x 300 x 150mm, 300 x 300 x 175mm and 300 x 300 x 200mm were cast for flexural strength of slab. Twenty(20) slabs were produced for with slab thickness of 100mm, 125mm, 150mm, 175mm and 200mm using the mix ratios 0.5:0.5:2 & 0.5:0.75:2(WA:CF:SD) respectively. the mean values of the compressive strength, flexural strength and deflection were 14.9MPa & 15.78MPa, 5.06MPa to 5.52MPa and 28.9mm to 86.5mm respectively.

KEYWORDS*;- Crack filler, sawdust, Wood adhesive, ETS, Flexural strength, compressive strength, Timber.*

Date of Submission: 06-10-2024 Date of acceptance: 18-10-2024

I. INTRODUCTION

Slab or otherwise called plate is described as a low critical structural element in building structure by virtue of the fact that it possess a spacial geometric planar area in relation to other structural elements [5]. Slab serves as a base element which can be constructed from different civil works construction materials. Most of these materials are very pricely in cost, possess high self-weight, extremely low flexural strength, cause eminent environmental hazards and other associated technical limitations[2]. The various categories of slab by in terms of their component civil works materials are composite slabs such as the regular steel reinforced concrete (SRC), steel-deck concrete slab, timber slab, particle board, plywood plated slab and bamboo reinforced slab. Some of these are engineered timber products[6]. Composite elements produced from both wood waste and agricultural products such as wood dust-palm kernel shell slab, wood dust-sand composite slab are categorized under Engineered Timber Product[1].

In the present era, the latter-day technology in the construction market has made composite construction system greatly known to the world of construction due to its economy and light-weight characteristics[4]. Composite system of Civil works is a broadly adopted construction technology where two or more different engineering materials exhibit a joint engineering function[6].

Steel deck concrete slab pose a high failure due to slippage and shear but also has a high compression strength and bending strength. It is found that the cost of obtaining a unit meter of the aforemention slab is ten times of an Engineered Timber slab(ETS)[10]. Standalone timber slab was found to be possess heterogeneous strength along and across its cross sectional zone. Its compressional and bending strength yields as time of loading bearing increases[9]. In the other hand, the regular SRC slab portrays high compression strength and high flexural strength but it possess high imposed weight and dead weight on the building columns which can result to collapse. Also, the cost of its component materials are on the increase as its unaffordable to low wage earners[7]. Finally, bamboo slab has a low modulus of elasticity value and possess strength only at its points of node. It is in a bid to ameliorate the setbacks that this research presents the Compressive & Flexural Strength performance of Low weight Engineered Timber Slab composed of wood adhesive, Saw dust, & crack filler to take care of cost, shear failure, low flexural strength and excessive self-weight[3].

II. MATERIALS

The materials involved in this study include: (i) Wood adhesive (WA) (ii) Crack filler (CF) (iii) Sawdust (SD) (iv) palm kernel shell(PKS) (v) water

2.1 Wood adhesive (WA)

Wood adhesive fell within the standard of IS 6337-2009 was gotten from Imo Timber milling market. It contains urea. The wood adhesive is also in conformity with the specifications of ISO 848 -2011 and BS 4350 (1999) . The selection of adhesive used was made based on its urea percentage, high adhesive strength and slip strength, high viscosity, resistance to moisture and its workability with fillers such as wood dust and crack fillers.

2.2 Crack filler (CF)

Crack filler was purchased from the Timber milling market, Owerri West LGA, Imo State, Nigeria. The crack filler was classified according to the results of its physical characteristics as from laboratory analysis.

2.3 Sawdust (SD)

SD was gotten from the Timber milling market, Owerri West LGA, Imo State, Nigeria. The sawdust was classified in comformity to the results of its physical characteristics as carried out in the laboratory.

2.4 Palm kernel shell (PKS)

PKS was procured from the palm kernel milling site located in Umuokanne Village, Umuagwo Autonomous community, Ohaji / Egbema LGA, Imo State, Nigeria. First, the PKS was washed and boiled to remove any oil and fat from it. The PKS was grinded into smaller fine sizes. The PKS was be classified in relation to the results of its physical characteristics as carried out in the laboratory.

III. METHODS

i. Carry out the physical characteristics of all component materials in the laboratoty such as bulk density, water absorption,
ii. Batch each component material (SD, CF & WA) by volume in line with the stipulated blend ratio.
iii. Blend all the batched components aggregates in a container. Thoroughly mix together.
iv. Spray the weighed water on the blend materials using a shovel to achieve the proper homogenous mix. Then reweigh the mixed mortar.
v. Clean and prepare the cube and square mould and rap up the internal wall surface with nylon for both compressive and flexural strength respectively.
vi. Pour the weighed mix uniformly and in layers. Apply pressure to ram it into the metallic mould using a metallic rammer for about 20times until the mixture reaches its maximum density while in the mould.
vii. Allow the fresh mix specimen remain in mould for 3weeks and demould it carefully and sun dry.
viii. The same test method were adopted for all mix ratio.
ix. Finally test the dry specimen for both compressive and flexural strength using the universal testing machine and Magnus frame apparatus respectively.

IV. RESULT

The results of this research are presented on Table 1 to Table 4 and Figure 1

Table 1, Table 2, Table 3 & Table 4 represents the mix proportions, dry density, compressive strength & flexural strength respectively

Table 1: Proportion for blending

SLAB TAG	QTY	BLEND RATIO	THICKNESS OF SLAB ELEMENT (mm)	GEOMETRIC VOLUME OF SLAB ELEMENT(mm3)	FACTORED VOLUME OF MATERIALS(mm3)			
					ADHESIVE	CRACK FILLER	SAWDUST	
AA1	DUPLICATED	0.5: 0.5 : 2	125	11250000	1875000	1875000	7500000	_
AA2		0.5: 0.5 : 2	150	13500000	2250000	2250000	9000000	_
AA3		0.5: 0.5 : 2	175	15750000	2625000	2625000	10500000	_
AA4		0.5: 0.5 : 2	200	18000000	3000000	3000000	12000000	_
AA5		0.5: 0.5 : 2	225	20250000	3375000	3375000	13500000	_
AB1		0.5: 0.75 : 2	125	11250000	1730769	2596153.846	6923076.9	_
AB2		0.5: 0.75 : 2	150	13500000	2076923	3115384.615	8307692.3	_
AB3		0.5: 0.75 : 2	175	15750000	2423077	3634615.385	9692307.7	_
AB4		0.5: 0.75 : 2	200	18000000	2769231	4153846.154	11076923	_
AB5		0.5: 0.75 : 2	225	20250000	3115385	4673076.923	12461538	_

Table 2: Dry Density of ETS cubes

Blend ratio (WA: CF: SD)	Element No	Volume of Element(m^3)	Mass of Element (Kg)	Dry Density in Kg/m^3	Mean Dry Density in Kg/m^3
0.5: 0.5 : 2	A	0.003375	4.82	1428.15	**1446.914**
0.5: 0.5 : 2	B	0.003375	4.88	1445.93	
0.5: 0.5 : 2	C	0.003375	4.95	1466.67	
0.5: 0.75 : 2	A	0.003375	5.18	1534.81	**1534.815**
0.5: 0.75 : 2	B	0.003375	5.15	1525.93	
0.5: 0.75 : 2	C	0.003375	5.21	1543.70	

Table 3: Compressive Test results of ETS cubes

Blend ratio (WA: CF: SD)	Element No	Surface Area of Element (mm^2)	Mass of Element (Kg)	Crush Force (KN)	Compressive Strength (N/mm^2)	Mean Compressive strength (N/mm^2)
0.5: 0.5 : 2	A	22500	4.82	334.3	14.86	**14.91**
0.5: 0.5 : 2	B	22500	4.88	341.5	15.18	
0.5: 0.5 : 2	C	22500	4.95	330.7	14.70	
0.5: 0.75 : 2	A	22500	5.18	349.56	15.54	**15.78**
0.5: 0.75 : 2	B	22500	5.15	352.76	15.68	
0.5: 0.75 : 2	C	22500	5.21	362.66	16.12	

Table 4: Flexural Test results of Engineered Timber Slab

SLAB SYMBOL	MIX RATIO	THICKNESS(mm)	Crushing Load(KN)	Flexural strength(N/mm2)	Deflection (mm)	Average Deflection
AA1	0.5: 0.5 : 2	125	125.16	5.34	87.2	**86.5**
			125.39	5.35	85.8	
AA2	0.5: 0.5 : 2	150	186.64	5.53	74.2	**74.9**
			185.96	5.51	75.6	
AA3	0.5: 0.5 : 2	175	249.44	5.43	51.2	**50.95**
			249.90	5.44	50.7	
AA4	0.5: 0.5 : 2	200	313.80	5.23	33.4	**34**
			315.00	5.25	34.6	
AA5	0.5: 0.5 : 2	225	384.24	5.06	29.3	**28.95**
			383.48	5.05	28.6	
AB1	0.5: 0.75 : 2	125	128.44	5.48	30.2	**30.95**
			128.91	5.50	31.7	
AB2	0.5: 0.75 : 2	150	186.98	5.54	44.6	**44.15**
			187.65	5.56	43.7	
AB3	0.5: 0.75 : 2	175	248.52	5.41	50.9	**50.7**
			249.44	5.43	50.5	
AB4	0.5: 0.75 : 2	200	315.60	5.26	39.9	**40.05**
			314.40	5.24	40.2	
AB5	0.5: 0.75 : 2	225	386.52	5.09	29.6	**29.85**
			385.00	5.07	30.1	

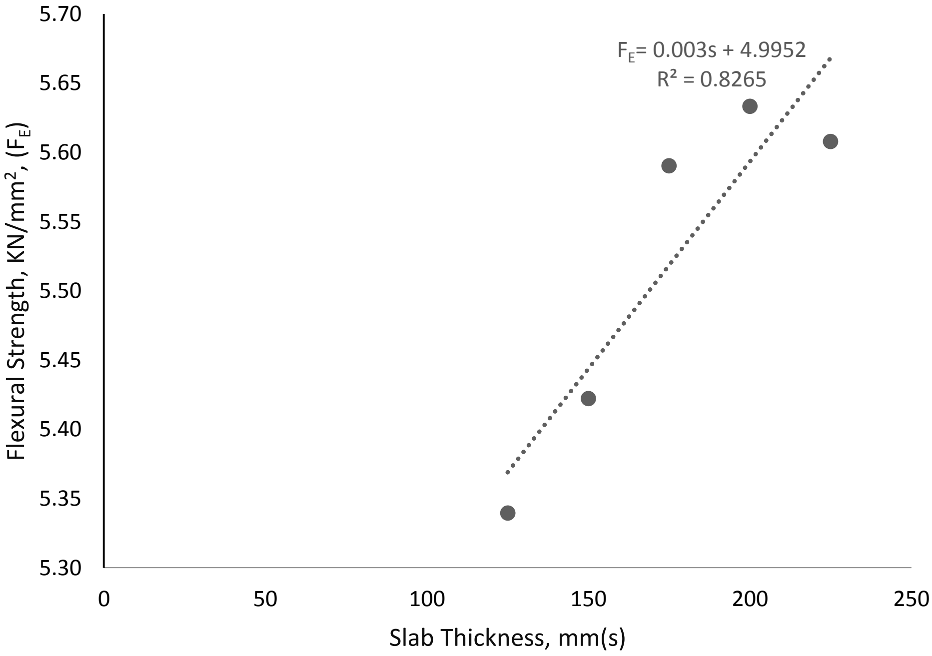

Figure 1: Linear Correlationship graph of Flexural strength of ETS against Slab thickness using 0.5: 0.5:2 mix ratio

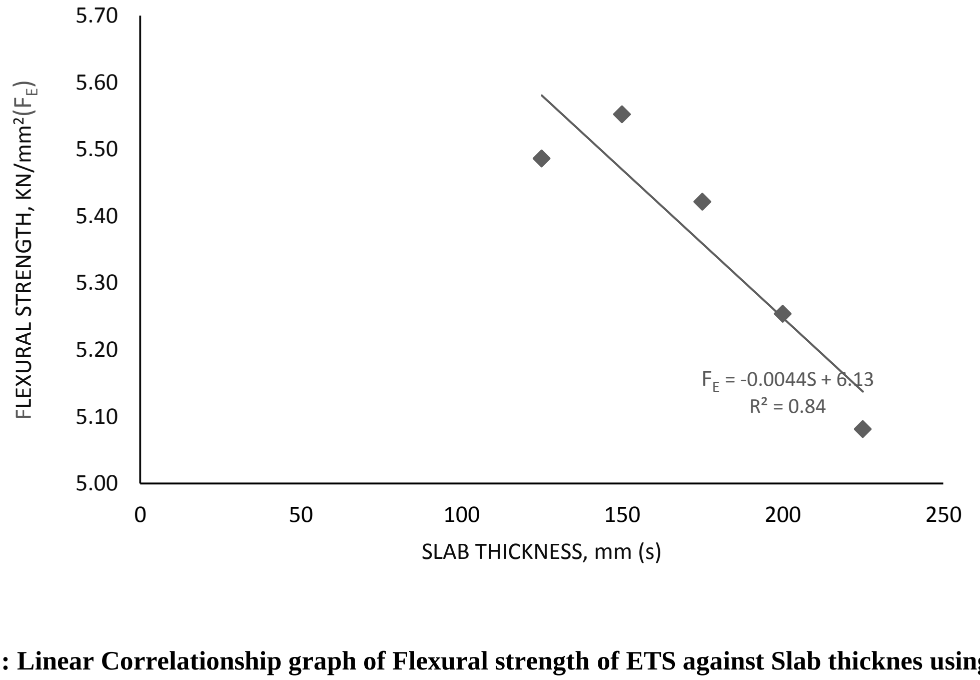

Figure 2: Linear Correlationship graph of Flexural strength of ETS against Slab thicknes using 0.5: 0.75:2 mix ratio.

V. DISCUSSION

The Mean compression strength of Engineered Timber cubes were 14.9MPa and 15.8MPa for blend ratio 0.5: 0.5 : 2 and 0.5: 0.75 : 2 respectively according to Table 3. The values derived conforms with that of the timber veneer specie (Obeche) ranging from 11.2 – 13.01MPa for structural purposes.

From Table 2, the mean density of Engineered timber cubes were 1446.9 Kg/m³ and 1534.8 Kg/m³ for blend ratio 0.5: 0.5 : 2 and 0.5: 0.75 : 2 respectively. The density of light-weight concrete should not exceed 1900kg/m^3. Therefore, Engineered timber cube is a light- weight element with respect to its unit weight.

From Table 4, the average flexural strength of Engineered timber slab ranged from 5.06MPa to 5.52MPa for blend ratio 0.5: 0.5 : 2 and 5.08MPa to 5.55MPa for blend ratio 0.5: 0.75 : 2. The highest bending strength were recorded on 150mm thick slab for both mix ratios while the least bending strength were recorded on 225mm thick slab for both mix ratios. The allowable flexural strength of the timber veneer specie (Obeche) ranged from 6.92MPa to 7.36MPa. Also the allowable bending strength for light weight structural element ranges from 2.6Mpa to 15Mpa. Therefore the flexural strength of ETS failed below the allowable benchmark of of light weight element.

VI. CONCLUSION

From Table 3, the mean compressive strength of ETS cubes were 14.91MPa and 15.78MPa for blend ratio of 0.5: 0.5 : 2 and 0.5: 0.75 : 2 respectively. The values derived are about 25.2% and 29.3% respectively higher than the mean compressive value of the timber veneer specie (Obeche wood specie) ranging from 10.2 12.01MPa for structural purposes. Also, from Table 4, The average flexural strength of ETS for both mix ratio 0.5: 0.5: 2 and 0.5: 0.75: 2 failed beneath the threshold limit of timber veneer specie (Obeche wood specie) and light weight element. Conclusively, The average density of Engineered Timber slab lies within the threshold of light weight concrete.

REFERENCE

[1]. Fosser Delha (2001). Standard for plasticized slab element. Masonry Journal 20, 10-12.

[2]. Zanab Vonne (1999). Disparity in Flexural strength of slab. *Civil works & Structures journal. PP 16.*

[3]. Anselem Frico J.(1999). Regressional Analysis for light-weight strength of structural elements. The American College of statistics 30, 12-15.

[4]. Fredrick Sico (2005). Effect of Sawdust in Concrete Mix. International Journal of Civil and Structural Engineering(no.4):213-270.

[5]. British Standard Institute.(2001).BS 5028,1364 : 1964. Guideline for lightweight block.pp 40..

[6]. Abadin Scott. (2012).Materials for Civil Works.Darya Ganj,New Delhi:Khanna Publishers.

[7]. Lunt.M.G. (1980). Stabilized soil blocks for building. Overseas Building Notes, Building Research Establishment, Gartson.

[8]. Lannes Piroh.(2010). Alternation to River Sand using palm kernel shell in slab construction. Journal of Civil Works Practice and Technologies 20, 90-92.

[9]. Ntama Victor(2016).. Advanced optimization of light weight concrete. World Journal Engineering Science:134-143